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SOLARTRON

Instruction Manual

for

L. F. Decade Oscillator

Type OS103.2/A

THE SOLARTRON ELECTRONIC GROUP LTD,

Farnborough Hampshire England

MP MASTER
MA24434

INSTRUCTION MANUAL
FOR
LOW FREQUENCY DECADE OSCILLATOR
MODEL OS.103.2

(Prov. Pat. No. 5465/54)

PREFACE

The widespread introduction of servo techniques to aircraft, manufacturing machinery of all kinds, and to process control has created a demand for new testing methods. The Solartron Low Frequency Decade Oscillator, combined with the Solartron Resolved Component Indicator, have for some time been widely used for these tests. An improved model of the oscillator has now been produced with improved performance figures. It provides a four-phase sinusoidal output of excellent waveform and good amplitude stability. Output level indication is by means of a thermocouple meter, which gives a substantially steady response down to 0·01 c/s.

Amplitude stability is achieved by a technique of squaring and limiting in the oscillator feedback network.

The phases are balanced in amplitude to $\pm$ 1% at frequencies from 0·01 c/s to 1 Kc/s and the phase relationship between the outputs is accurate to $\pm$ 1° over the entire oscillator range.

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SECTION 1
PERFORMANCE SPECIFICATION

1. Frequency Range
0·01 c.p.s.–11·1 c.p.s. in steps of 0·01 c.p.s. with multipliers of 10, 100 and 1,000, giving a maximum frequency of 11·1 Kc/s.

2. Frequency Accuracy
± 1·5%.

3. Sinewave Output
Four-phase output is provided, each phase giving 10 volts rms with respect to earth. All phases are nominally at zero quiescent voltage.
The 0° and 180° outputs have a source impedance of less than 2 ohms and will, in each case, deliver the 10 volts output into 1,000 ohms, i.e.
Unbalanced output:—100 mw. into 1,000 ohms.
Balanced output:— 200 mw. into 2,000 ohms.
The 90° and 270° outputs are available on 100 ohms output impedance and are intended for reference purposes only.

4. Phase Balance
The angular accuracy of the quadrature phases is within ± 1° of nominal.
The amplitudes of the 90°, 180° and 270° phases are within ± 1% up to 1 Kc/s, ± 2% above 1 Kc/s of the amplitude of the 0° phase.

5. Level Indicator
A special metering system, calibrated from 9 to 11 volts rms per phase, is provided. This metering system will, to a first order, maintain a steady indication of rms voltage, even at the subsonic frequencies.

6. Harmonic Distortion
Approximately 1% for each of the four phases.

7. D.C. Content
Less than 1% of the peak/peak A.C. voltage for all four phases.

8. Output Dividing System
In order to maintain low D.C. content at low output levels, the oscillator operates at a constant level of 10 volts rms per phase and is followed by a voltage dividing system operative on the 0° and 180° outputs. This voltage dividing system will deliver the following voltages per phase into a 1,000 ohm terminating resistance:—

10 volts to 5 volts in 0·5 volt steps
5 volts to 2 volts in 0·25 volt steps
2 volts to 1 volt in 0·1 volt steps

Further multipliers are provided of x0·1 and x0·01, thus giving 99 steps in all, covering 10 volts to 10 mV unbalanced or 20 volts to 20 mV balanced.

Note: *Dividers are not provided for the* 90° *and* 270° *outputs.*

9. Squarewave Output
A squarewave output with respect to earth is simultaneously available. The output voltage is approximately 18 V peak/peak, and the output impedance approximately 600 ohms. A 10 KΩ potentiometer is provided for reduction of the squarewave output level.

The rise time of the square wave is in the order of 1% of the periodic time at all frequencies.

10. Mains Requirements
90–130 V and 200–240 V 50/60 c/s with a total consumption of 220 V.A.

11. Presentation
Standard rack panel 19 in. × 12¼ in. high, but mounted in a 'Solartron' bench-type case.

SECTION 2
OPERATING INSTRUCTIONS

1. Before connecting the instrument to the mains supply check that the mains selection panel setting agrees with the supply voltage. This selecting panel and the mains lead are housed behind a small door at the bottom rear of the right-hand side of the case.
2. Connect the instrument to the mains supply, switch on and allow 10 minutes to warm up. Check that the decade frequency selectors are never all simultaneously set to zero. Adjust the 'SET TO 10 V' control, so that the meter reads 10. The instrument is now ready for use.
3. The oscillator is intended to work at 10 V, and should not be operated with meter reading deviations of more than 5% from this figure. An attenuator is provided to reduce output voltage.
4. The output attenuator will deliver the rms voltages indicated by the controls, either balanced or unbalanced, into an impedance of 1 KΩ from each phase to earth.
Internal 1 KΩ resistors may be switched into circuit when the external impedance is very high.
When the external impedance is greater than but comparable with 1 KΩ, additional shunt loading must be added to obtain an output loading of 1 KΩ.

5. The 90° and 270° quadrature outputs are available at high impedance only and no attenuator is provided.
6. The required frequency should always be set up using the lowest multiplier setting in order to obtain the best performance from the oscillator.
7. The level indicator will have a slight beat at very low frequencies due to mismatching of the meter thermocouples. The required reading is the average reading over a complete cycle of oscillation.
8. Frequencies in the very low region will take a number of cycles to build up, making setting-up a long and tedious business. To avoid this, the following technique is recommended.
Set in the required frequency on the lower decade switches, and set the top decade switch to 100. Adjust the voltage to 10 V and switch the upper decade switch back to the required position.
If, after several cycles, the level is found to be either high or low, return to the higher frequency, set in an equal and opposite error and return to the required frequency. The level should now be correct.

9. The meter in the oscillator is a thermocouple device whose sensitivity is subject to fluctuations with temperature. A sensitivity control is provided on the front panel so that the meter may be adjusted against a suitable external meter at a suitable frequency.

Note: *When setting the required frequency always use the lowest multiplier setting and the highest decade switch.*

SECTION 3
PRINCIPLES OF OPERATION

1. The oscillator employs two R.C. phase-shift networks coupled by suitable maintaining amplifiers. Novel methods of level indication and amplitude stabilisation have been employed because of the very low frequency of oscillation and these are discussed below.

2. Amplitude Stabilisation

The difficulties of satisfactory amplitude stabilisation at very low frequencies are fully recognised, and every endeavour has been made to produce a satisfactory solution. The main sources of amplitude variation with frequency are the bandwidth of the inter-connecting amplifiers, and misalignment of the R.C. phase-shift networks. A change in transmission of 0·1% in any of these giving rise to an output change of up to 2%.
The various amplifiers and inverters in the system have been designed to have a flat response from D.C. to 10 Kc/s by using negative feedback. The R.C. networks used are simple series R & C combinations which, when fed with a balanced signal, give a constant output voltage whose phase varies with frequency (Fig. 1).

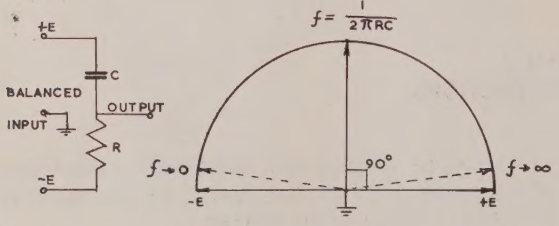


FIG 1

When the loop consisting of the maintaining amplifier and phase-shift networks is closed, there is just insufficient gain to maintain oscillation, and the loop acts as a sensitive selective amplifier. If a constant amplitude squarewave, whose fundamental frequency is the tune frequency of the amplifier, is supplied as the input signal to the amplifier, the sinewave output will also be of constant amplitude. This output sine-

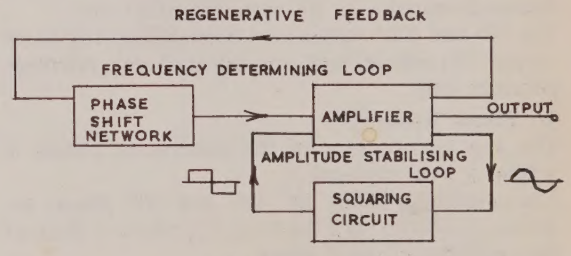


FIG 2

wave may then be reshaped to a squarewave to provide the input signal (Fig. 2). The oscillator thus becomes self-maintaining.
The selective amplifier has an effective Q of about 20 which results in a final distortion in the output waveform of about 1%.
3. At various points throughout the oscillator, there exist voltage waveforms at 0°, 90°, 180° and 270°. These are used for the reference and signal outputs. In addition, the 0° and 90° signals are used in the level indicating system. These two voltages, E Sin ωt and E Cos ωt are fed into two thermocouples through suitable series resistors (Fig. 3). The voltage outputs are connected in series addition. As the voltage output is approximately proportional to the square of the input current, the meter deflection is proportional to $E^2 \sin^2 \omega t + E^2 \cos^2 \omega t$, i.e. E^2. The meter indication is thus independent of frequency and, in the ideal case, is steady down to the lowest frequencies.

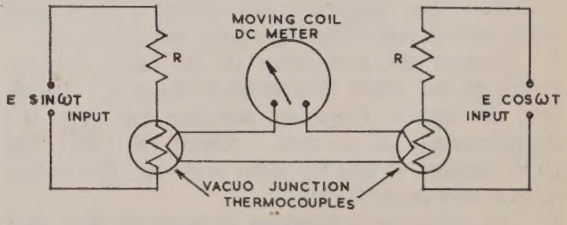


FIG 3

SECTION 4
TECHNICAL DESCRIPTION

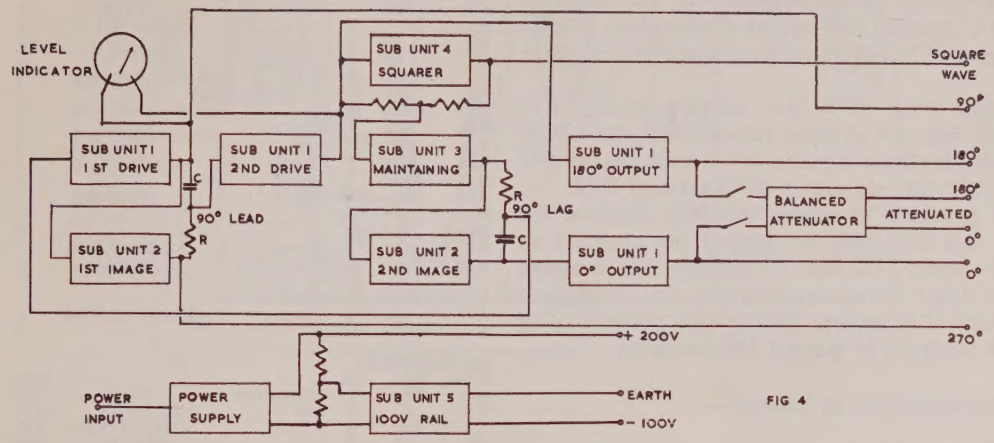


FIG 4

4.1. The equipment is built up from ten sub-units, together with the main wiring. There are only six different types of sub-unit and these are used as follows (Fig. 4).

Sub-Unit 1
1st Drive Amplifier
2nd Drive Amplifier
0° Output Amplifier
180° Output Amplifier

Sub-Unit 2
1st Image Amplifier
2nd Image Amplifier

Sub-Unit 3
Maintaining Amplifier

Sub-Unit 4
Squarer

Sub-Unit 5
Negative Voltage Generator

Sub-Unit 6
Power Supply

Technical description, setting-up instructions, component values and circuit diagrams are given for each unit in turn.

A final section describes the complete equipment and gives a brief description of performance checks and fault-finding procedure.

To remove the instrument from its case, remove the four panel-fixing screws at the sides of the panel, and the single screw through the bottom of the case at the rear. Open the door in the right-hand side of the case and check that the mains lead is not trapped. Withdraw the instrument from the case.

To remove any of the sub-units one to five, unscrew the captive fixing screw which holds the sub-unit chassis to the main assembly, and withdraw the sub-unit from the rear of the frame. When replacing these sub-units, ensure that the plug on the sub-unit mates correctly with the socket on the main assembly.

To remove the power supply sub-unit remove the heat shield which is held in place by three countersunk screws through the back member of the frame, unplug the power supply from the socket attached to the front panel. Remove the four fixing bolts which hold the power unit to the bottom of the frame. The unit may then be removed through the rear of the frame. With all sub-units removed, all remaining parts of the equipment are accessible. The front panel may be removed from the frame if required by unsoldering two leads, unplugging the two 'micronectors', and unscrewing the panel-fixing screws.

The following abbreviations and notes are applicable to the component lists.

(1) Notes:—

Blank spaces indicate no change from the preceding line.

In some instances, direct equivalents from other manufacturers may be used.

(2) Abbreviations:—

H.S.	High stability.
W.W.	Wire wound.
M.P.	Metallised paper.
Ce	Ceramic.
M.S.M.	Moulded silvered mica.
T.C.C.	Telegraph Condenser Co.
G.E.C.	General Electric Co.
S.T.C.	Standard Telephones and Cables.

4.2. SUB-UNIT 1

This sub-unit contains a unity gain negative feedback amplifier consisting of three valves.

V1 is a low-noise pentode type EF86 which receives its input through the grid stopper R1. The output of V1 is D.C. coupled through the divider chain R5, R6 to the grid of V2, a second amplifying pentode type EF91.

The output from V2 is D.C. coupled through R12 and R13, into the cathode follower V3, an A2134. A negative feedback signal is taken from the cathode of V3 to the cathode circuit of V1 through RV2.

RV1 is provided to adjust the D.C. level of the output, and RV2 sets the gain of the amplifier to precisely unity. C1 and C3 provide HF coupling between stages to reduce phase errors at the highest frequencies of operation. C2, R11 is a phase shaping network designed to prevent HF instability.

Plug connections are as follows:—

A1	6·3 V A.C.	B1	Signal Input
A2	6·3 V A.C.	B2	—
A3	Earth	B3	+ 200 V
A4	— 100 V	B4	—
		B5	Signal Output

Setting-up Procedure

Connect the sub-unit to correct H.T. and L.T. supplies and allow to warm up.

Connect an avometer, model 8, from the amplifier output (B5) to earth (A3).

Inject an input signal of 10 V 100 c/s to the input (B1) from an oscillator having a low D.C. resistance from its output to earth.

Measure the signal output with an accurate A.C. voltmeter of high input impedance.

Adjust RV2 so that the signal output is identical with the signal input.

Adjust RV1 for zero D.C. output.

Check both adjustments.

The following quiescent potentials are given as a guide only. They are measured with respect to the earth line using an avometer, model 8. The amplifier input is short circuited.

Valve No.	Pin No.	Meter Reading	Meter Range
V1	1 & 6	97 V	100 V
	3	2 V	2·5 V
V2	5	106 V	250 V
	7	95 V	100 V
	1	—1 V	2·5 V
V3	5	200 V	250 V
	7	198 V	250 V
	1	—18·7 V	25 V

Table 1.

Components

RESISTORS (FIXED)

Circuit Ref.	Value Ohms	Tol. %	Manufacturer	Type	Rating Watts	Solartron Part No.
R1	100	10	Erie	9 Carbon	¼	226313
R2	120k	10			¼	226350
R3	82k	1	Painton	73 H.S.	¼	223688
R4	47k	1			¼	223682
R5	1M	1			¼	223714
R6	1M	1			¼	223714
R7	100	10	Erie	9 Carbon	¼	226313
R8	39k	10			¼	226344
R9	47k	10			¼	226345
R10	56k	1	Painton	73 H.S.	¼	223684
R11	680	10	Erie	9 Carbon	¼	226323
R12	1·2M	1	Painton	73 H.S.	¼	223716
R13	820k	1			¼	223712
R14	100	10	Erie	9 Carbon	¼	226313
R15	220	10			¼	226317
R16	22	10			¼	226305
R17	4·7k	1	Painton	P406 W.W.	3	238265
R18	330	10	Erie	9 Carbon	¼	226319

RESISTORS (VARIABLE)

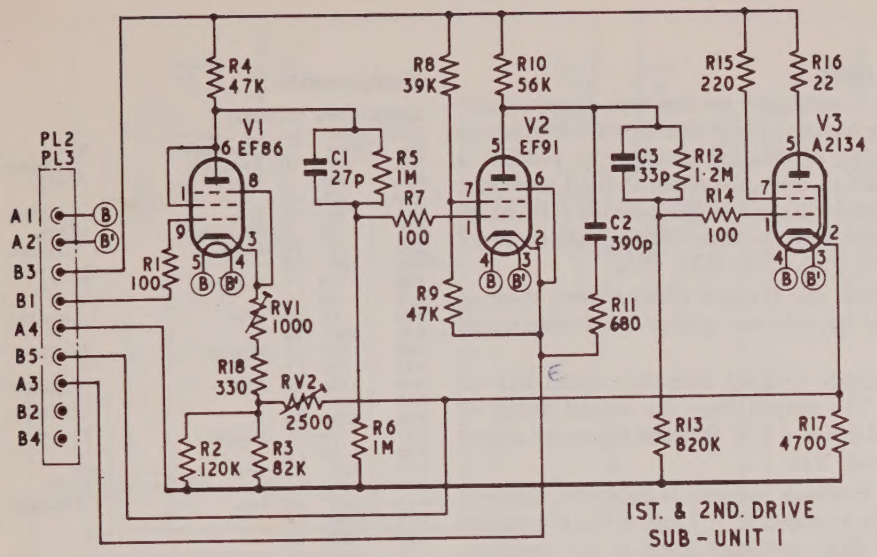
RV1	1k	10	Colvern	CLR1206/9S W.W.	¼	256410
RV2	2·5k	10			¼	256411

CAPACITORS

Circuit Ref.	Value Pfd.	Tol. %	Manufacturer	Type	Rating Volts	Solartron Part No.
C1	27	2	Erie	N150L Ce	500	N20109
C2	390	2	T.C.C.	CSM20N M.S.M.	350	N20116
C3	33	2	Erie	N150L Ce	500	N20111

VALVES

Circuit Ref.	Type	Description	Manufacturer
V1	EF.86	Pentode	Mullard
V2	EF.91		
V3	A.2134		G.E.C.



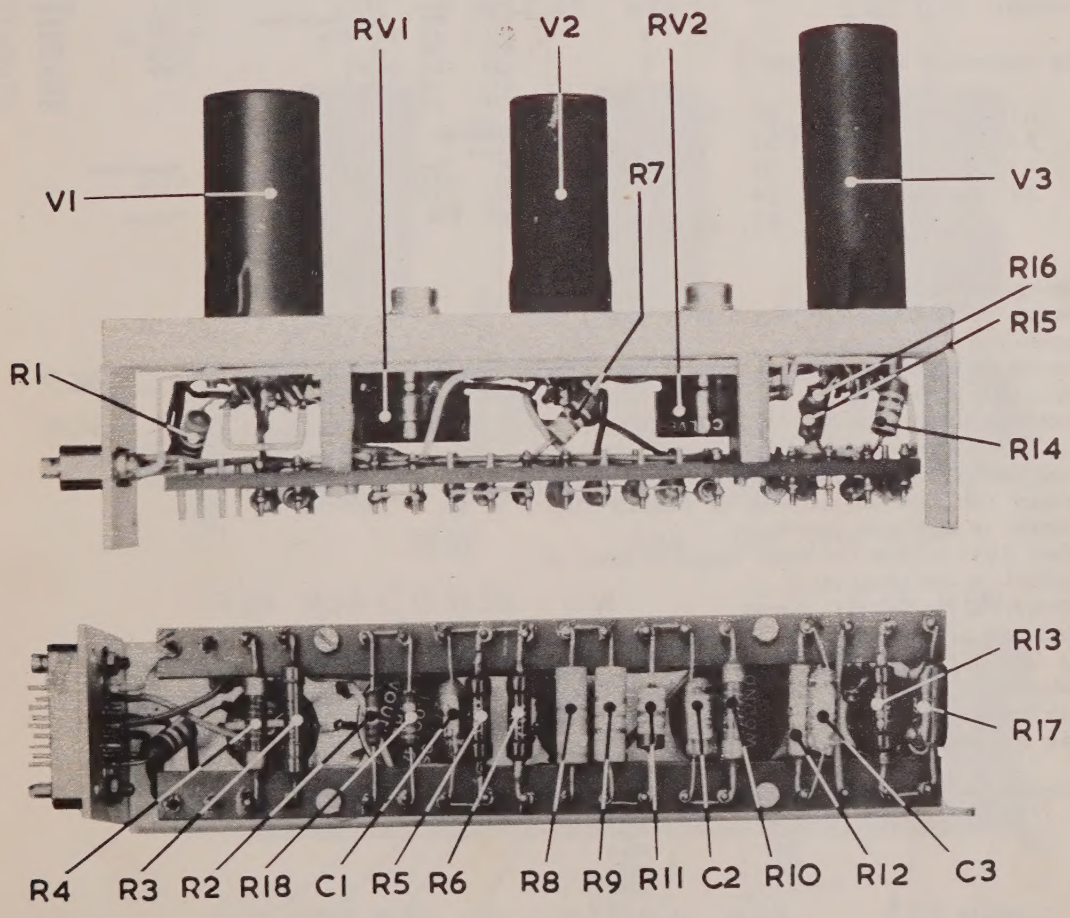


Plate 1: Sub-Unit 1

4.3. SUB-UNIT 2

Sub-unit 2 is a unity gain see-saw type negative feedback amplifier having a phase-shift of 180°. It is used in the oscillator as an imaging amplifier to produce a balanced signal to drive the phase-shifting networks. The first amplifying stage is the pentode V13 which derives its signal from the virtual earth of the feedback network RV11, R32, C14; R33, C15.

The output from the anode is divided down through R48, R47 and fed into one grid of the double triode V12.

V12 is a cathode coupled amplifier which has no phase-shift. The output from the second anode of V12 is divided down in R38, R39 and drives the output cathode follower V11.

RV11 in the feedback network is provided to adjust the gain of the amplifier to − 1 and RV12 is provided to adjust the D.C. quiescent levels in the amplifier. C11, C13, C14 and C15 are provided to reduce phase-shifts at higher operating frequencies. C12, R40 form a phase-shaping network which prevents HF instability.

Plug connections are as follows:—

A1	6·3 V A.C.	B1	Signal Input
A2	6·3 V A.C.	B2	—
A3	Earth	B3	+ 200 V
A4	− 100 V	B4	—
		B5	Signal Output

Setting-up Procedure

Connect the sub-unit to correct H.T. and L.T. supplies and allow to warm up.

Connect an avometer, model 8, from the amplifier output (B5) to earth (A3).

Inject an input signal of 10 V 100 c/s to the input (B1) from an oscillator having a low D.C. resistance from its output to earth.

Measure the signal output with an accurate A.C. voltmeter of high input impedance.

Adjust RV11 so that the signal output is equal in amplitude to the signal input.

Adjust RV12 for zero D.C. output.

Check both adjustments.

The following quiescent potentials are given as a guide only. They are measured with respect to the earth line using an avometer, model 8. The amplifier input is short circuited.

Valve No.	Pin No.	Meter Reading	Meter Range
V11	1 & 6	200 V	250 V
	2 & 7	−2 V	2·5 V
V12	1	95 V	100 V
	6	200 V	250 V
	7	−5 V	10 V
	3 & 8	2 V	2·5 V
V13	6	89 V	100 V
	1	106 V	250 V
	3	2 V	2·5 V

Table 2.

Components

RESISTORS (FIXED)

Circuit Ref.	Value Ohms	Tol. %	Manufacturer	Type	Rating Watts	Solartron Part No.
R31	100	10	Erie	9 Carbon	¼	226313
R32	20k	1	Painton	73 H.S.	¼	223673
R33	22k	1			¼	223674
R34	22	10	Erie	9 Carbon	¼	226305
R35	12k	5	Welwyn	F5 MF	2	235638
R36	22	10	Erie	9 Carbon	¼	226305
R37	100	10			¼	226313
R38	1M	1	Painton	73 H.S.	¼	223714
R39	1M	1			¼	223714
R40	1k	10	Erie	9 Carbon	¼	226325
R41	100	10			¼	226313
R42	47k	1	Painton	73 H.S.	¼	223682
R43	27k	1			¼	223676
R44	330k	10	Erie	9 Carbon	¼	226355
R45	22	10			¼	226305
R46	100	10			¼	226313
R47	1M	1	Painton	73 H.S.	¼	223714
R48	1M	1			¼	223714
R49	150	2	Erie	109	⅛	221105
R50	47k	1	Painton	73	¼	223682
R51	100	10	Erie	9 Carbon	¼	226313
R52	56k	10			¼	226346
R53	100k	10			¼	226349

RESISTORS (VARIABLE)

RV11	5k	10	Colvern	CLR1206/9S W.W.	¼	256412
RV12	1k	10			¼	256410

CAPACITORS

Circuit Ref.	Value Pfd.	Tol. %	Manufacturer	Type	Rating Volts	Solartron Part No.
C11	4·7	·25pF	Erie	P100K Ce	500	201009
C12	47	10		N150L	500	N20113
C13	6·8	·25 pF		P100K	500	201011
C14	10	10			500	N20078
C15	4·7	·25 pF			500	201009

VALVES

Circuit Ref.	Type	Description	Manufacturer
V11	12AT7	Double Triode	S.T.C.
V12	12AT7		
V13	EF86	Pentode	Mullard

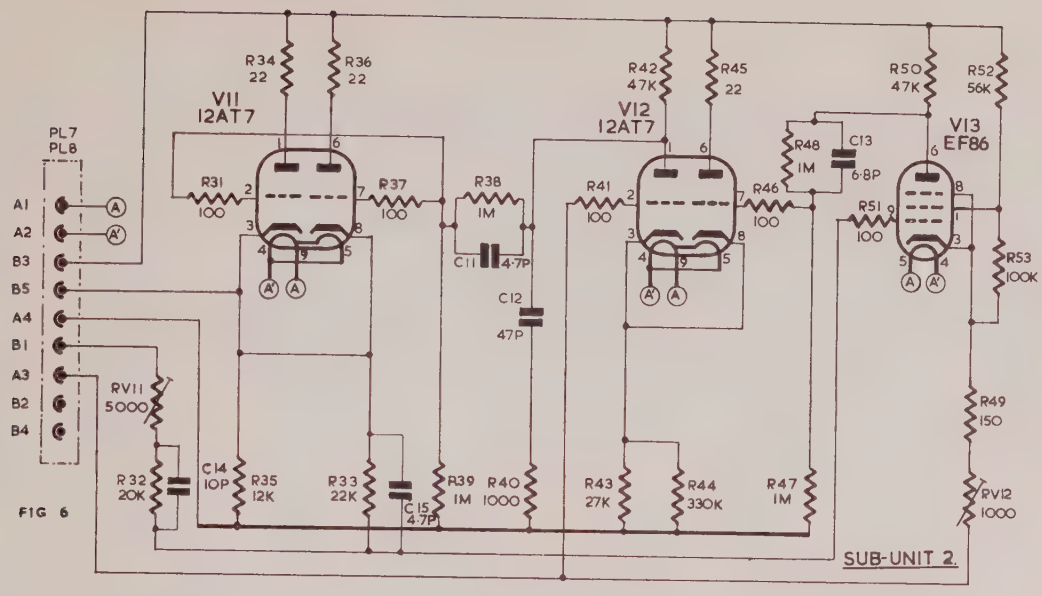


FIG 6

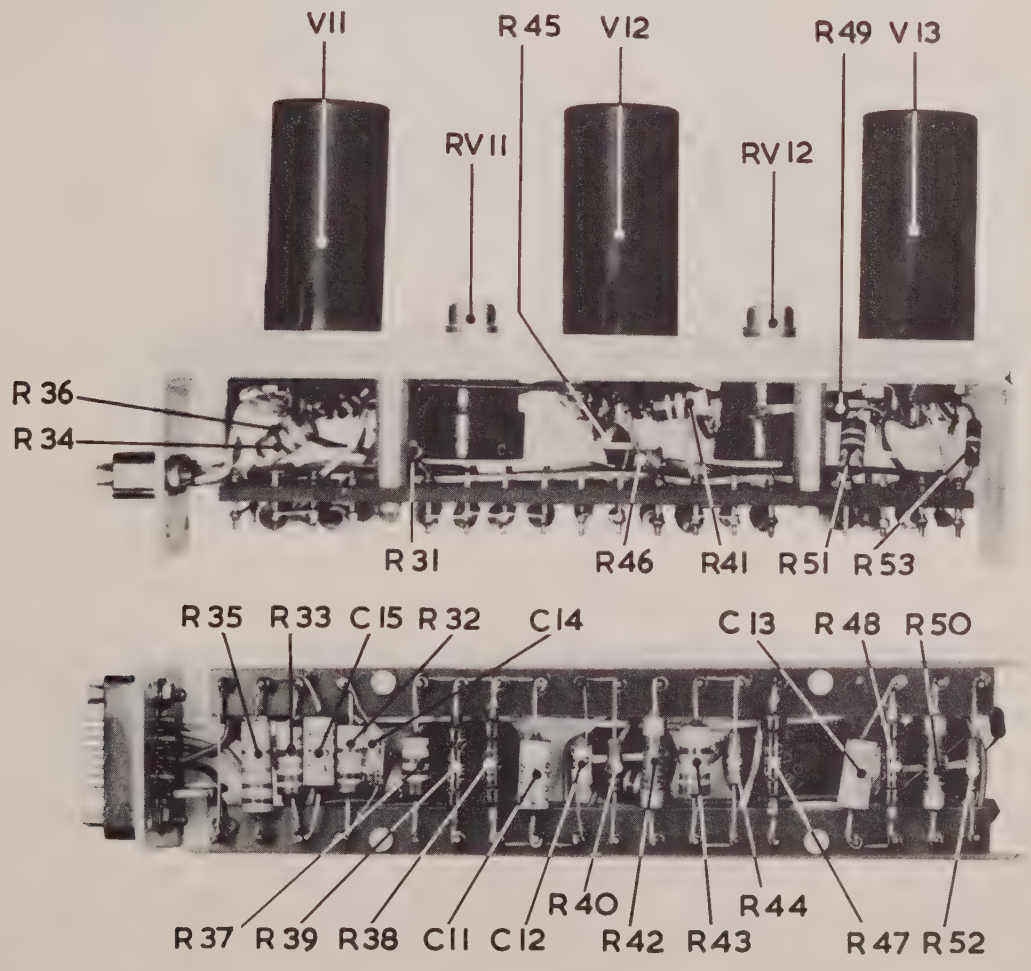


Plate 2: Sub-Unit 2

4.4. SUB-UNIT 3

Sub-unit 3 is a negative feedback amplifier similar in configuration to sub-unit 1. V21, an EF86, and V22, an EF91, are the amplifying stages, and V23, a 12AT7, is the output cathode follower. Negative feedback is taken from the cathode of V23 to the cathode of V21 through R67. The gain of this sub-unit is fixed and is approximately 1·35. C22 and C24 provide HF compensation of the D.C. coupling networks, to reduce phase-shift at the higher operating frequencies, and C21, R68 and C23, R73, are phase-shaping networks which prevent high frequency instability. RV21 is provided to set up the D.C. quiescent potentials in the unit.

Plug connections are as follows:—

A1	6·3 V A.C.	B1	Signal Input
A2	6·3 V A.C.	B2	—
A3	Earth	B3	+ 200 V
A4	— 100 V	B4	—
		B5	Signal Output

Setting-up Procedure

Connect the sub-unit to correct H.T. and L.T. supplies and allow to warm up.

Connect an avometer, model 8, from the amplifier output (B5) to earth (A3).

Inject an input signal of 10 V 100 c/s to the input (B1) from an oscillator having a low D.C. resistance from its output to earth.

Measure the signal output with an accurate A.C. voltmeter of high input impedance.

Adjust RV21 for zero D.C. output.

Check that the A.C. output is 13·5 V ± 0·5 V.

The following quiescent potentials are given as a guide only. They are measured with respect to the earth line using an avometer, model 8. The amplifier input is short circuited.

Valve No.	Pin No.	Meter Reading	Meter Range
V21	6	94·5 V	100 V
	1	107 V	250 V
	3	2 V	2·5 V
V22	5	100 V	250 V
	7	200 V	250 V
	1	−3 V	10 V
V23	1 & 6	200 V	250 V
	2 & 7	−1·5 V	2·5 V

Table 3.

Components

RESISTORS (FIXED)

Circuit Ref.	Value Ohms	Tol. %	Manufacturer	Type	Rating Watts	Solartron Part No.
R61	100	10	Erie	9 Carbon	¼	226313
R62	47k	10			¼	226345
R63	47k	1	Painton	73 H.S.	¼	223681
R64	68k	10	Erie	9 Carbon	¼	226347
R65	220k	10			¼	226353
R66	27k	1	Painton	73 H.S.	¼	223676
R67	7·5k	1			¼	223663
R68	390	10	Erie	9 Carbon	¼	226320
R69	1M	1	Painton	73 H.S.	¼	223714
R70	1M	1			¼	223714
R71	100	10	Erie	9 Carbon	¼	226313
R72	56k	1	Painton	73 H.S.	¼	223684
R73	470	10	Erie	9 Carbon	¼	226321
R74	1M	1	Painton	73 H.S.	¼	223714
R75	1M	1			¼	223714
R76	100	10	Erie	9 Carbon	¼	226313
R77	10k	5	Welwyn	F5 MF	2	235637
R78	22	10	Erie	9 Carbon	¼	226305
R79	22	10			¼	226305
R80	100	10			¼	226313

RESISTORS (VARIABLE)

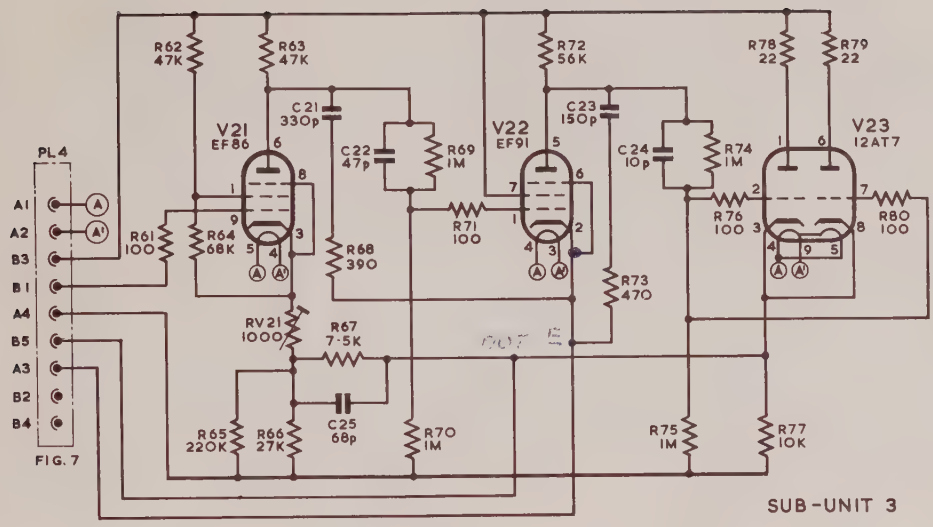
RV21	1k	10	Colvern	CLR1206/9S W.W.	¼	256410

CAPACITORS

Circuit Ref.	Value Pfd.	Tol. %	Manufacturer	Type	Rating Volts	Solartron Part No.
C21	330	10	T.C.C.	CSM20N M.S.M.	350	N20118
C22	47	10	Erie	N150L Ce	500	N20113
C23	150	10	T.C.C.	CSM20N M.S.M.	350	N20119
C24	10	10	Erie	P100K Ce	500	N20078
C25	68	10	T.C.C.	CSM20N M.S.M.	350	N20114

VALVES

Circuit Ref.	Type	Description	Manufacturer
V21	EF86	Pentode	Mullard
V22	EF91		
V23	12AT7	Double Triode	S.T.C.



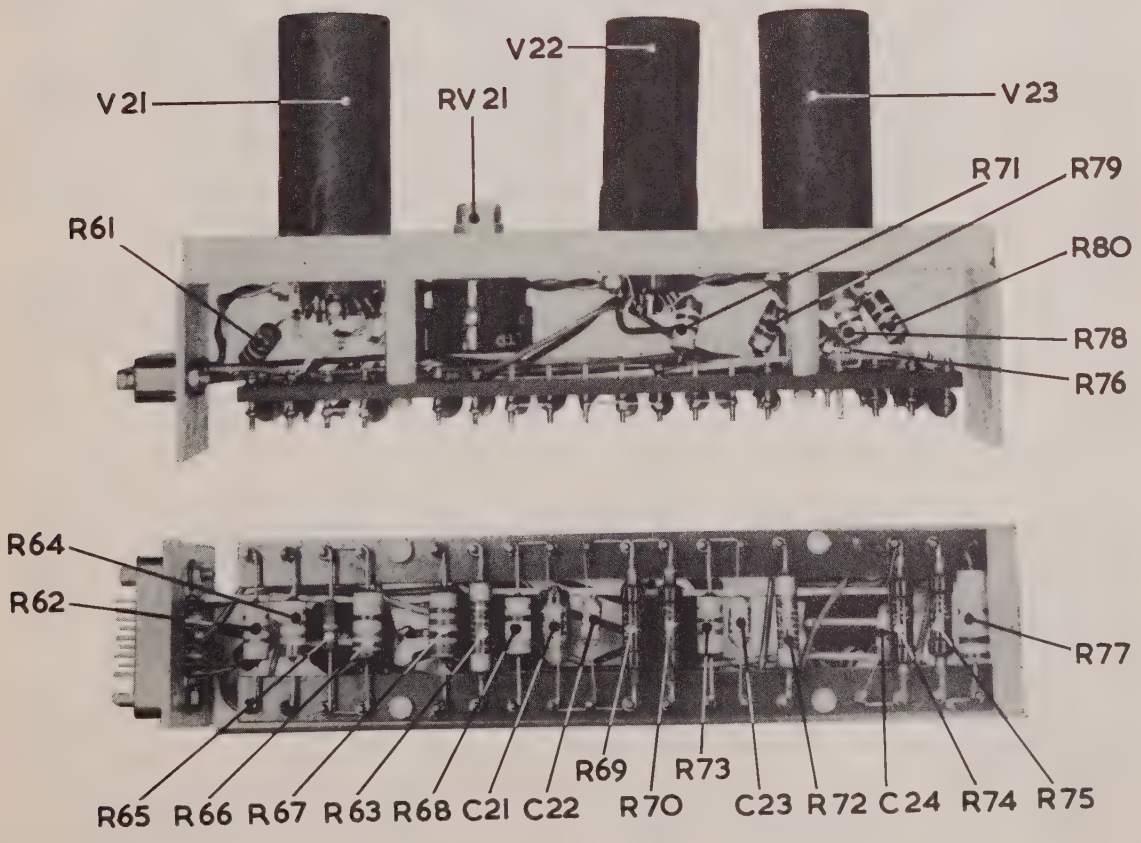


Plate 3: Sub-Unit 3

4.5. SUB-UNIT 4

Sub-unit 4 contains the squaring circuits. V31, a 12AX7, is connected as a cathode coupled limiting circuit which will give a squarewave output from a sinusoidal input. RV31 is provided to adjust the register potential of the second grid of the limiter, and this gives control of the mark to space ratio. The squarewave output from pin 6 is D.C. coupled into the grid of V32A a cathode follower. C31 is provided to correct the coupling at HF for best squarewave response. RV32 is provided to set the D.C. quiescent level at the cathode of the cathode follower. The squarewave from this cathode provides a sqaurewave output, and also a signal for V33, a second cathode coupled limiter. This stage is again succeeded by a cathode follower, and gives a second squarewave output which has a faster rise time than the first. C33 adjusts the coupling for optimum wave shape, and RV33 sets the D.C. levels.

Plug connections are as follows:—

A1	6·3 V A.C.	B1	Signal Input
A2	6·3 V A.C.	B2	—
A3	Earth	B3	+ 200 V
A4	— 100 V	B4	2nd Signal Output
		B5	1st Signal Output

Setting-up Procedure

Connect the sub-unit to correct H.T. and L.T. supplies and allow to warm up.

Connect an avometer, model 8, from the first output (B5) to earth (A3).

Inject an input signal of 10 V 100 c/s to the input (B1) from an oscillator having a low D.C. resistance from its output to earth.

Examine the signal output on a suitable cathode-ray oscilloscope.

Adjust RV31 to obtain a 1 : 1 mark to space ratio.

Adjust RV32 for zero D.C. output.

Adjust C31 for best squarewave, i.e. minimum overshoot and droop.

Check that the output waveform has an amplitude of approximately 15 V P–P.

Connect the avometer and the oscilloscope between the second output (B4) and earth.

Check that the output waveform has an amplitude of approximately 18 V P–P.

Adjust RV33 for zero D.C. output.

Adjust C33 for best squarewave, i.e. minimum overshoot and droop.

The following quiescent potentials are given as a guide only. They are measured with respect to the earth line using an avometer, model 8. The input was short circuited.

Valve No.	Pin No.	Meter Reading	Meter Range
V31	1	200 V	250 V
	6	192 V	250 V
	7	−3·2 V	10 V
	3 & 8	2 V	2·5 V
V32	1	200 V	250 V
	2	−30 V	100 V
	6	200 V	250 V
	7	−24 V	100 V
V33	1	200 V	250 V
	6	190 V	250 V
	7	−5 V	10 V
	3 & 8	5 V	10 V

Table 4.

Components

RESISTORS (FIXED)

Circuit Ref.	Value Ohms	Tol. %	Manufacturer	Type	Rating Watts	Solartron Part No.
R91	100	10	Erie	9 Carbon	¼	226313
R92	22	10			¼	226305
R93	47k	1	Painton	73 H.S.	¼	223682
R94	100k	1	Erie	109	¼	221073
R95	100	10		9 Carbon	¼	226313
R96	200k	1	Painton	73 H.S.	¼	223697
R97	100k	1	Erie	109	¼	221073
R98	1·8M	1	Painton	73	¼	223720
R99	910k	1			¼	223713
R100	100	10	Erie	9 Carbon	¼	226313
R101	22	10			¼	226305
R102	27k	2	Welwyn	Welmet MF	1	235383
R103	100	10	Erie	9 Carbon	¼	226313
R104	22	10			¼	226305
R105	56k	1	Painton	73 H.S.	¼	223684
R106	100k	1	Erie	109	¼	221073
R107	100	10		9 Carbon	¼	226313
R108	200k	1	Painton	73 H.S.	¼	223697
R109	100k	1	Erie	109	¼	221073
R110	1·6M	1	Painton	73	¼	223719
R111	820k	1			¼	223712
R112	100	10	Erie	9 Carbon	¼	226313
R113	22	10			¼	226305
R114	27k	2	Welwyn	Welmet MF	1	235383

RESISTORS (VARIABLE)

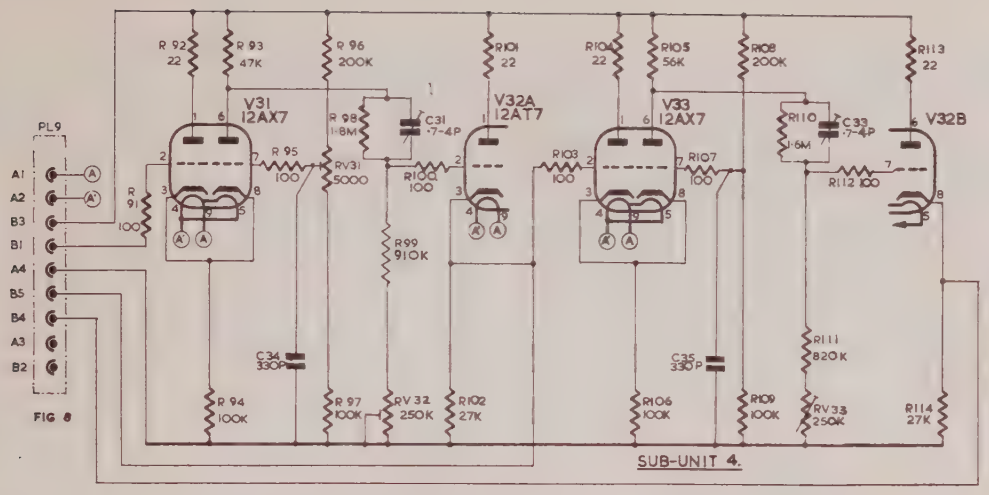
RV31	5k	10	Colvern	CLR1206/9S W.W.	¼	256412
RV32	250k	20	Morgan	L.H.	¼	251209
RV33	250k	20			¼	251209

CAPACITORS

Circuit Ref.	Value Pfd.	Tol. %	Manufacturer	Type	Rating Volts	Solartron Part No.
C31	0·7/4		Wingrove & Rogers	S50-01/1 P.T.F.E.	1000	243001
C32			NOT FITTED			
C33	0·7/4		Wingrove & Rogers	S50-01/1 P.T.F.E.	1000	243001
C34	330	10	T.C.C.	CSM20N M.S.M.	350	N20118
C35	330	10			350	N20118

VALVES

Circuit Ref.	Type	Description	Manufacturer
V31	12AX7	Double Triode	S.T.C.
V32	12AT7		
V33	12AX7		



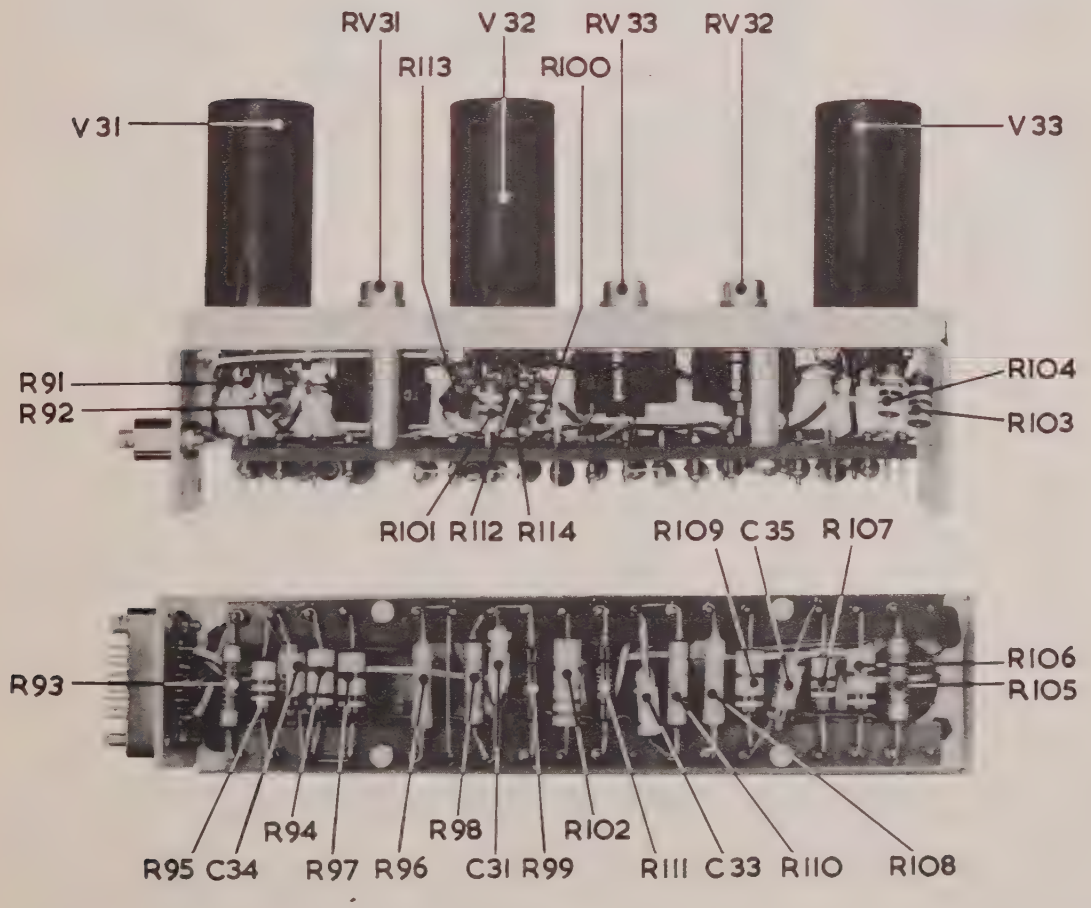


Plate 4: Sub-Unit 4

4.6. SUB-UNIT 5

Sub-unit 5 contains a unity gain D.C. coupled negative feedback amplifier similar in configuration to sub-unit 1. V41 and V42 (EF91) are the two amplifying stages, and V43 (A2134) is the output cathode follower. The input to this amplifier is a potential 100 V above the negative H.T. and the output is earthed. The input potential is established by the network R122, R123 and RV41. RV41 is adjusted so that the — ve H.T. is precisely 100 V.

The cathodes of all three valves are commoned to earth which gives negative feedback from V43 to V41, and positive feedback from V43 to V42.

The output is at very low impedance. C41 and C42 are provided to maintain the H.F. response of the unit.

Plug connections are as follows:—

A1	6·3 V A.C.	B1	—
A2	6·3 V A.C.	B2	—
A3	Earth	B3	+ 200 V
A4	— 100 V	B4	—
		B5	—

Setting-up Procedure

Connect 6·3 V A.C. to pins A1 and A2 and an isolated 300 V supply positive end to B3 and negative end to A4.

Connect a wire-wound resistor 1·5 K 6 W in parallel with 2 μFd and 0·47Ω in series from pin A3 to pin A4.

Connect an avometer, model 8, on 250 V range from A3 to A4.

Adjust RV41 so that A3 is precisely 100 V positive with respect to A4.

The following quiescent potentials are given as a guide only. They are measured with respect to point A3 using an avometer, model 8.

Valve No.	Pin No.	Meter Reading	Meter Range
V41	5	96 V	100 V
	7	175 V	250 V
	1	—5 V	10 V
V42	5	65 V	100 V
	7	133 V	250 V
	1	—1·5 V	10 V
V43	5	200 V	250 V
	7	200 V	250 V
	1	—13·5 V	25 V

Table 5.

Components

RESISTORS (FIXED)

Circuit Ref.	Value Ohms	Tol. %	Manufacturer	Type	Rating Watts	Solartron Part No.
R122	220k	1	Painton	73 H.S.	¼	223698
R123	100k	1	Erie	109	¼	221073
R124	100	10		9 Carbon	¼	226313
R125	39k	10			¼	226344
R126			NOT FITTED			
R127	56k	1	Painton	73 H.S.	¼	223684
R128	1M	1			¼	223714
R129	1M	1			¼	223714
R130	100	10	Erie	9 Carbon	¼	226313
R131	39k	10			¼	226344
R132			NOT FITTED			
R133	56k	1	Painton	73 H.S.	¼	223684
R134	1·1M	1			¼	223715
R135			NOT FITTED			
R136	820k	1	Painton	73 H.S.	¼	223712
R137	100	10	Erie	9 Carbon	¼	226313
R138	220	10			¼	226317
R139	22	10			¼	226305

RESISTORS (VARIABLE)

RV41	10	Reliance	M.W.	1	N25018

CAPACITORS

Circuit Ref.	Value Pfd.	Tol. %	Manufacturer	Type	Rating Volts	Solartron Part No.
C41	10	10	Erie	P100K Ce	500	N20078
C42	10	10			500	N20078

VALVES

Circuit Ref.	Type	Description	Manufacturer
V41	EF91	Pentode	Mullard
V42	EF91		
V43	A2134		G.E.C.

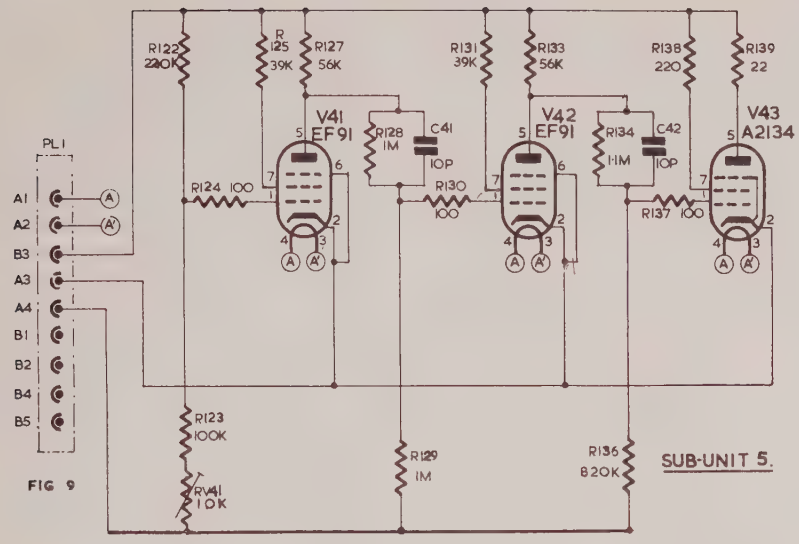


FIG 9

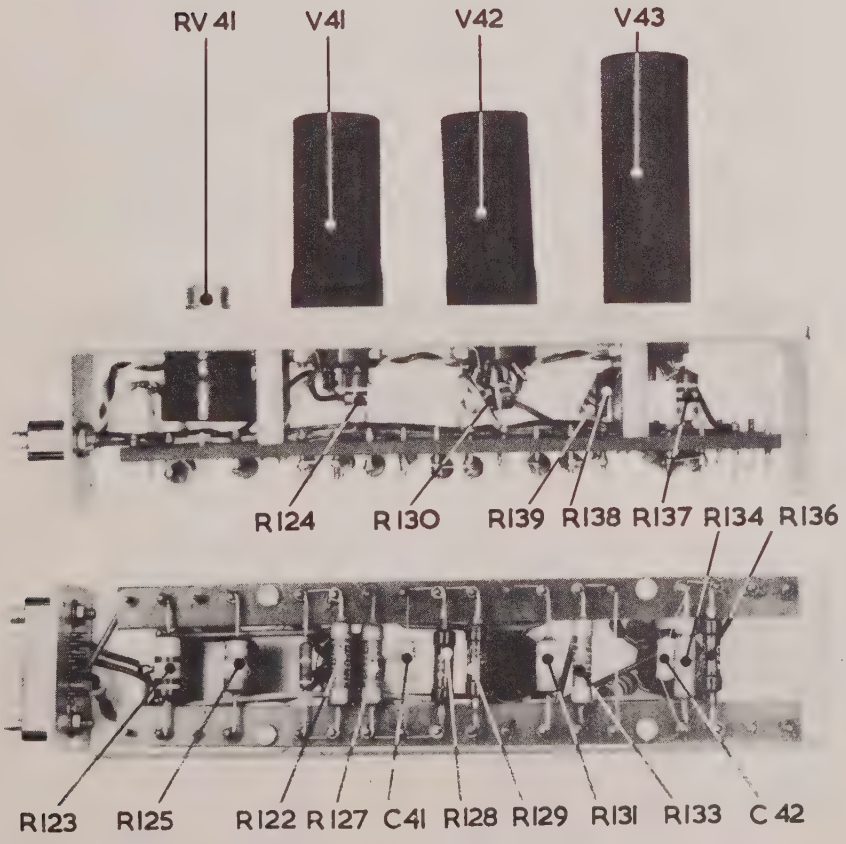


Plate 5: Sub-Unit 5

4.7. SUB-UNIT 6

The circuit used in the power unit is composed of :—

1. A Stable Voltage Reference
2. A Sampling Chain
3. A D.C. Amplifier
4. Series Control Valves
5. An Unstabilised Power Supply

These are connected together as shown in the accompanying block diagram (Fig. 10).

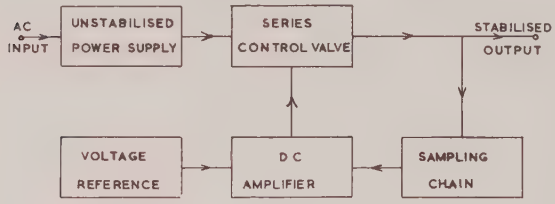


FIG 10

A proportion of any change which appears on the stabilised output is fed through the sampling chain into the D.C. amplifier. It is then amplified and fed to the grid of the series control valve. This alters the volt drop across the series valve in such a sense as to oppose the initial change. The final magnitude of the change is a function of the gain of the D.C. amplifier. The voltage reference is a Mullard 85A2 operating at a current of 6 mA approximately. This valve has a burning voltage of 85 V.

The sampling chain is a series of high stability carbon resistors connected between the stabilised H.T. + and H.T. —. It acts as a potential divider supplying signal to the D.C. amplifier.

The D.C. amplifier consists of two pairs of valves forming two cathode coupled differential amplifiers in cascade.

The first stage both halves of V6 compares a portion of the reference voltage with a portion of the H.T. voltage. The push-pull output of this stage is directly coupled to the second stage (both halves of V5) where further amplification takes place. The output from one side of the second amplifier controls the series stabilising valves.

First order compensation of D.C. drifts due to changes of heater voltage is automatic, since both sides of the differential amplifier tend to drift in the same direction, thus resulting in no output drift signal.

The series control valve carries the current drawn from the stabilised rail. Two A2293's V3 and V4 in parallel act as the series valve. They are fitted with anode and grid stoppers as a precaution against parasitic oscillation and resistors are connected in the cathodes to give some autobias and thereby aid load sharing.

The unstabilised power supply is of conventional form, consisting of a transformer feeding a full-wave rectifier and a choke input filter.

Performance Tests

Supply the unit with nominal mains, and correctly load all the A.C. and D.C. outputs. The voltage at the A.C. outlets should be $\pm 3\%$ of nominal. The D.C. potential can be accurately set by adjusting RV1.

Monitor D.C. stabilised line with a C.R.O. to ensure the absence of parasitic oscillations. Using an A.C. millivoltmeter check that the hum and noise

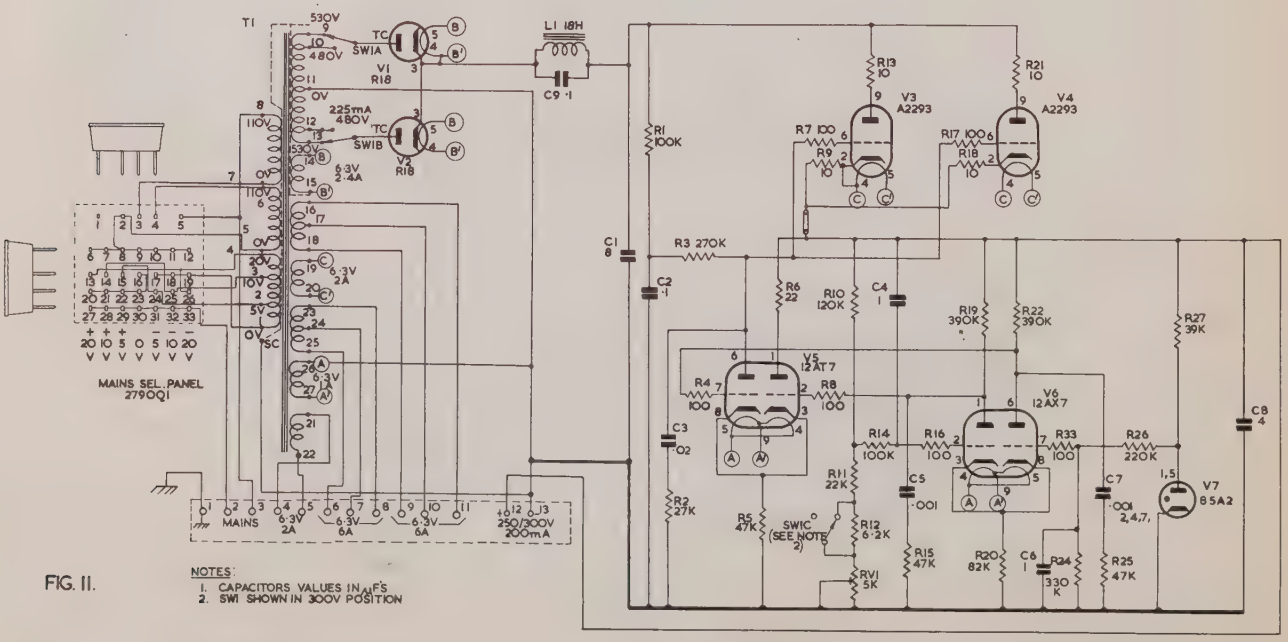


FIG. 11.

present on the D.C. output is less than that specified. The chassis should be earthed for this test.

Check that the changes of D.C. output are not measurable when the H.T. current is changed from full load to the permissible minimum, and when the mains input is varied $\pm 7\%$ about nominal.

The A.C. source impedance is measured by driving 5 mA A.C. into the stabilised output through a suitable capacitor, and measuring the A.C. potential across the output.

Quiescent Potentials

These potentials are supplied for information only and are not mandatory requirements. They were measured using an avometer, model 8, with its negative terminal attached to H.T. negative. The power supply sub-unit was operating at full load 300 V and supplied at nominal mains potential.

Valve No.	Pin No.	Meter Reading	Meter Range
V1 and 2	3	442	1000
V3 and 4	9	410	1000
V3 and 4	6	282	1000
V5	1	298	1000
V5	2*	185	250
V5	3 and 8	193	250
V5	6	282	1000
V5	7*	184	250
V5	1*	185	250
V6	2*	51	100
V6	3 and 8	52-2	100
V6	6*	184 V	250
V6	7*	48 V	100

* 12K resistor in series with the meter to prevent parasitic oscillation.

Table 6.

Components

RESISTORS

Circuit Ref.	Value Ohms	Tol. %	Manufacturer	Type	Rating Watts	Solartron Part No.
R1	100k	10	Erie	9 Carbon	¼	226349
R2	27k	10			¼	226342
R3	270k	10			¼	226354
R4	100	10			¼	226313
R5	47k	5	Morgan	R	1	228745
R6	22	10	Erie	9	¼	226305
R7	100	10			¼	226313
R8	100	10			¼	226313
R9	10	10			¼	226301
R10	120k	1	Painton	73 H.S.	½	223692
R11	22k	2	Erie	109	¼	221157
R12	6·2k	1			¼	221044
R13	10	10		9 Carbon	¼	226301
R14	100k	1		109 H.S.	½	221073
R15	47k	10		9 Carbon	¼	226345
R16	100	10			¼	226313
R17	100	10			¼	226313
R18	10	10			¼	226301
R19	390k	1	Painton	73 H.S.	½	223704
R20	82k	5	Morgan	R Carbon	1	228748
R21	10	10	Erie	9 Carbon	¼	226301
R22	390k	1	Painton	73 H.S.	½	223704
R23	100	10	Erie	9 Carbon	¼	226313
R24	330k	1	Painton	73 H.S.	½	223702
R25	47k	10	Erie	9 Carbon	¼	226345
R26	220k	1		109 H.S.	½	221081
R27	39k	5	Painton	P305 W. W.	5	239044
RV1	5k	10	Colvern	CLR/1206/9S	½	256412

CAPACITORS

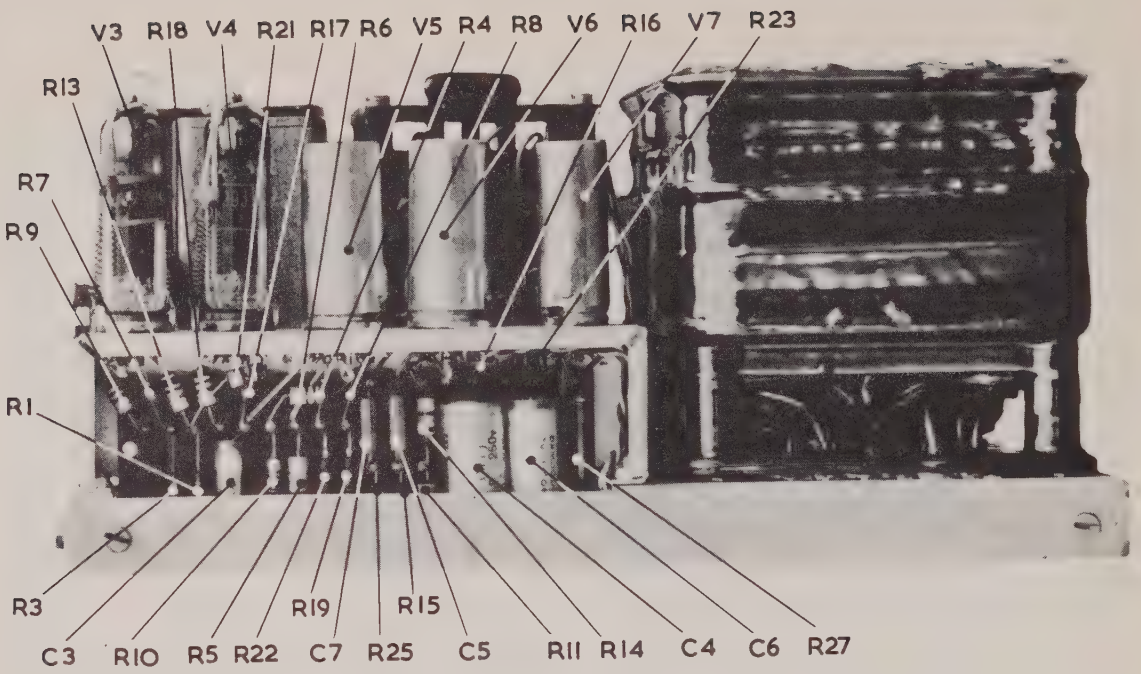
Circuit Ref.	Value µfd.	Tol. %	Manufacturer	Type	Rating Volts	Solartron Part No.
C1	8	20	T.C.C.	CP150T Paper	600	211204
C2	0·1	20		CP46S	500	214207
C3	0·02	20		CP33N	350	214103
C4	1	25	Hunt	B509 P M.P.	250	206605
C5	0·001	10	T.C.C.	CSM20N Mica	350	N20098
C6	1	20	Hunt	B503 M.P.	150	206504
C7	0·001	10	T.C.C.	CSM20N Mica	350	N20098
C8	4	20		CP149V Paper	800	211303
C9	0·1	20		CP47W.	1000	214407

VALVES

Circuit Ref.	Type	Description	Manufacturer
V1	R18	Rectifier	S.T.C.
V2	R18		
V3	A2293	Triode	G.E.C.
V4	A2293		
V5	12AT7	Double Triode	S.T.C.
V6	12AX7		
V7	85A2	Voltage Ref.	Mullard

MISCELLANEOUS

Circuit Ref.	Description	Supplier	Type
T1	Transformer	Parmeko	295024
L1	Choke	Parmeko	292004



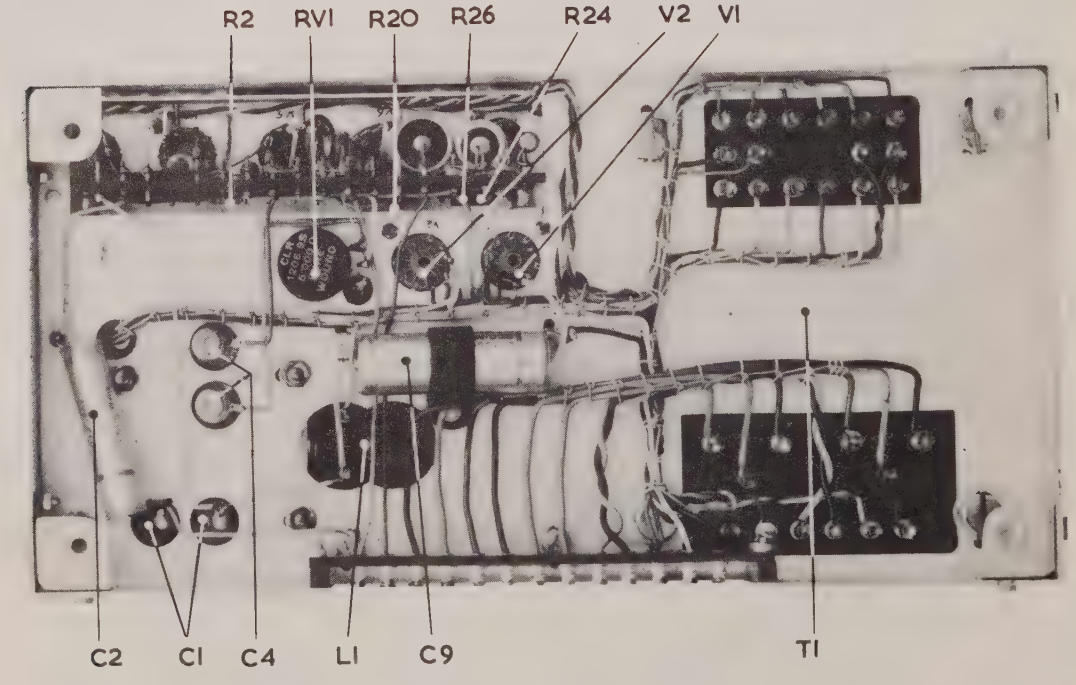


Plate 6: Power Supply Sub-Unit 6

4.8. THE PASSIVE NETWORKS

The major structure of the oscillator which houses all the sub-units contains the interconnecting wiring, the phase-shifting networks, the level indicator and level-setting controls and the signal attenuators.

The majority of the interconnecting wiring is on a printed circuit board which runs from end to end of the equipment. This carries all power supplies and signal connections from the individual sub-units to the passive networks and power sub-unit, through suitable plugs and sockets.

The two phase-shifting networks each consist of a capacitor in series with three resistive elements in parallel. The required pair of capacitors is selected by SW4, a four-pole four-position switch which acts as a frequency multiplier giving $\times 0{\cdot}1$, $\times 1$, $\times 10$ and $\times 100$.

The required three pairs of resistive elements are selected by three decade switches SW1, SW2 and SW3. These are eleven-position four-pole switches which are calibrated 0–100, 0–10 and 0–1 respectively, and determine the frequency to three significant figures.

The level indicating meter M1 is connected between earth and the outputs of the first and second drive amplifiers. The resistors in series with the thermocouples are R210, R211 together with both halves of RV60. RV60 provides an adjustment for the sensitivity of the meter, and is accessible at the front panel so that the meter may be corrected for variations of ambient temperature.

The output from the second drive amplifier is mixed with the output from the first squaring stage, in R212 and R213. The resultant signal is fed to the maintaining amplifier through an attenuator comprising R214, R216, RV61 A and B, and a further variable resistor selected by SW4/3R.

RV61 is the ' Adjust to 10 V ' control and the variable resistors selected by SW4/3R provide preset level setting, so that the four ranges may be adjusted to constant amplitude.

The output from the second stage of squaring is connected on to RV65, the squarewave amplitude control.

The balanced attenuator is connected in circuit by SW8. It consists of a balanced pair of sets of ladder attenuators.

The voltage selecting control (SW5) selects one from twelve series resistive elements which, when working into a 1 KΩ terminating impedance, give the required output voltage. The voltage range selector (SW6) gives a direct connection to the output on the maximum range and inserts $\times 0{\cdot}5$ and $0{\cdot}2$ ladder attenuators on the other two ranges.

The multiplier control (SW7) provides attenuations of $\times 1$, $\times 0{\cdot}1$ and $\times 0{\cdot}01$ by a further ladder attenuator.

The components mounted on the wafer switches are given in the following tables. In each case the components are given reading clockwise from the arrow.

SW1		SW2		SW3	
Front Bank	Rear Bank	Front Bank	Rear Bank	Front Bank	Rear Bank
R226	R189	R236	R199	R246	R209
R225	R188	R235	R198	R245	R208
R224	R187	R234	R197	R244	R207
R223	R186	R233	R196	R243	R206
R222	R185	R232	R195	R242	R205
R221	R184	R231	R194	R241	R204
R220	R183	R230	R193	R240	R203
R219	R182	R229	R192	R239	R202
R218	R181	R228	R191	R238	R201
R217	R180	R227	R190	R237	R200
				R291	

SW4	SW5		SW6		SW7
	Front Bank	Rear Bank	Front Bank	Rear Bank	Front Bank
C67	R273	R252	R279	R260	R285
C66	R274	R253	R280	R261	R283
C65	R275	R254	R278	R259	R284
C63	R276	R255	R281	R258	R282
C62	R277	R256			
C61	R268	R247			Rear Bank
	R269	R248			
	R270	R249			R264
	R271	R250			R262
	R272	R251			R265
	R267	R257			R263

Table 7.

Components

RESISTORS (FIXED)

Circuit Ref.	Value Ohms	Tol. %	Manufacturer	Type	Rating Watts	Solartron Part No.
R180	100k	½	Welwyn	C22 H.S.	¼	N22218
R181	50k	½			¼	N22219
R182	33·33k	½			¼	N22220
R183	25k	½			¼	N22221
R184	20k	½			¼	N22222
R185	16·67k	½			¼	N22223
R186	14·28k	½			¼	N22224
R187	12·5k	½			¼	N22225
R188	11·11k	½			¼	N22226
R189	10k	½			¼	N22227
R190	1M	½			¼	N22228
R191	500k	½			¼	N22229
R192	333k	½			¼	N22230
R193	250k	½			¼	N22231
R194	200k	½			¼	N22232
R195	166·7k	½			¼	N22233
R196	142·8k	½			¼	N22234
R197	125k	½			¼	N22235
R198	111·1k	½			¼	N22236
R199	100k	½			¼	N22218
R200	10M	½	Lab.	HS3 H.S.	¼	N22237
R201	5M	½			¼	N22238
R202	3·33M	½			¼	N22239
R203	2·5M	½			¼	N22240
R204	2M	½			¼	N22241
R205	1·667M	½			¼	N22242
R206	1·428M	½			¼	N22243
R207	1·25M	½			¼	N22244
R208	1·111M	½			¼	N22245
R209	1M	½	Welwyn	C22 H.S.	¼	N22228
R210	1·2k	1	Erie	109 H.S.	⅛	221027
R211	1·2k	1	Erie	109 H.S.	⅛	221027
R212	1k	1			⅛	221025
R213	18k	1			⅛	221055
R214	2·2k	1			⅛	221033
R215	680	1			⅛	221021
R216	8·2k	1			⅛	221047
R217	100k	½	Welwyn	C22 H.S.	¼	N22218
R218	50k	½			¼	N22219
R219	33·33k	½			¼	N22226
R220	25k	½			¼	N22221
R221	20k	½			¼	N22222
R222	16·67k	½			¼	N22223
R223	14·28k	½			¼	N22229
R224	12·5k	½			¼	N22225
R225	11·11k	½			¼	N22226
R226	10k	½			¼	N22227

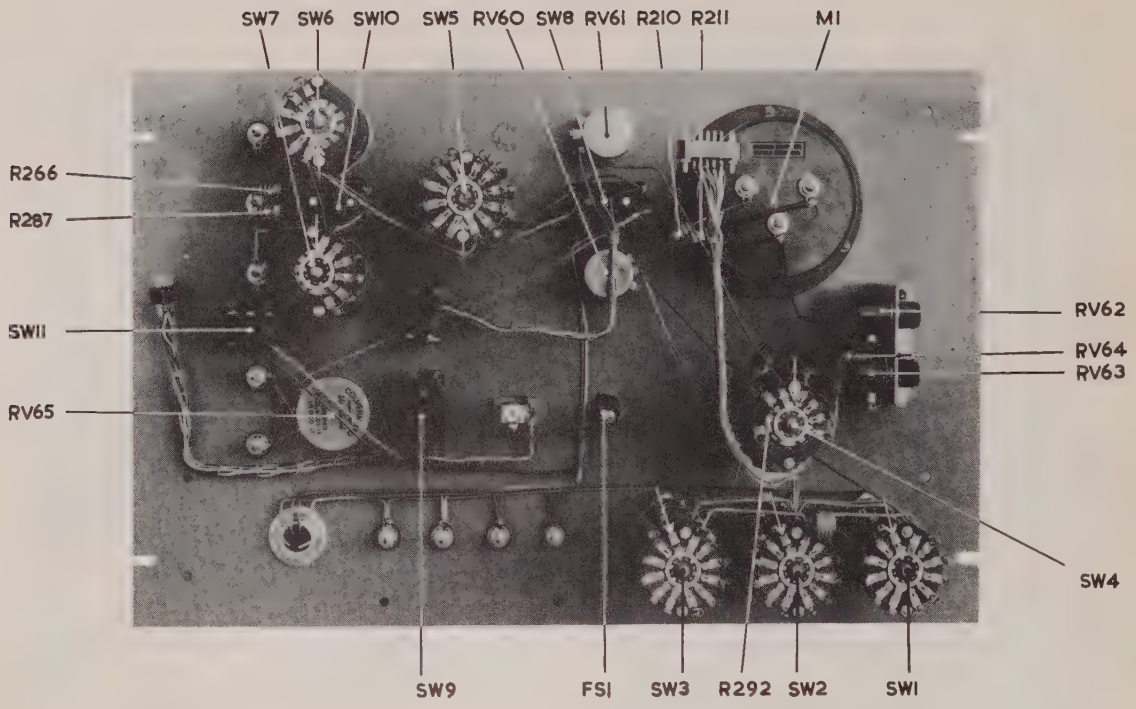


Plate 7: Rear view of front panel

(Components mounted on wafer switches are listed in Table 7)

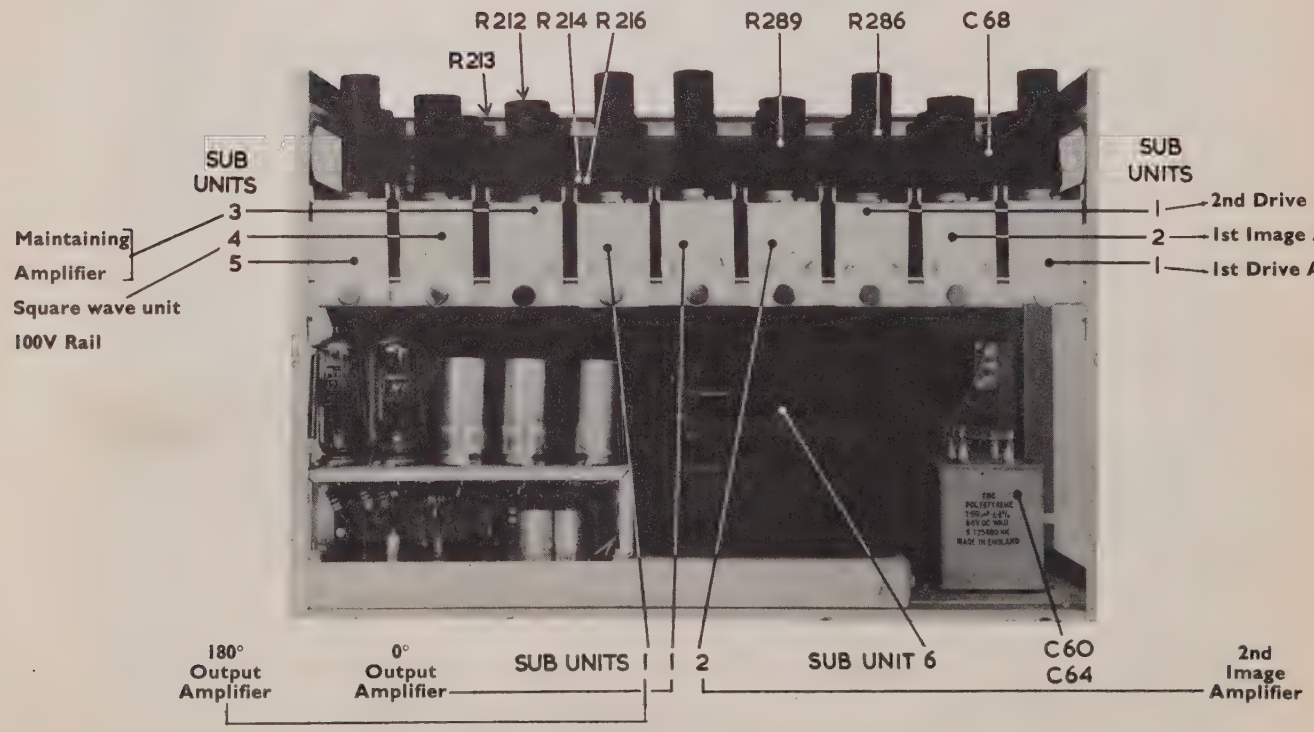


Plate 8: Rear view of instrument (case removed)

RESISTORS (FIXED) *(Continued)*

Circuit Ref.	Value Ohms	Tol. %	Manufacturer	Type	Rating Watts	Solartron Part No.
R227	1M	½			½	N22228
R228	500k	½			½	N22229
R229	333k	½			½	N22230
R230	250k	½			½	N22231
R231	200k	½			½	N22232
R232	166·7k	½			½	N22233
R233	142·8k	½			½	N22234
R234	125k	½			½	N22235
R235	111·1k	½			½	N22236
R236	100k	½			½	N22218
R237	10M	½	Lab.	HS3 H.S.	½	N22237
R238	5M	½			½	N22238
R239	3·33M	½			½	N22239
R240	2·5M	½			½	N22240
R241	2M	½			½	N22241
R242	1·667M	½			½	N22242
R243	1·428M	½			½	N22243
R244	1·25M	½			½	N22244
R245	1·111M	½			½	N22245
R246	1M	½	Welwyn	C22 H.S.	½	N22228
R247	660	1	Painton	73 H.S.	½	N22103
R248	962	1			½	N22104
R249	1466	1			½	N22105
R250	2475	1			½	N22106
R251	5500	1			½	N22107
R252	55	1			½	N22108
R253	122	1			½	N22109
R254	206	1			½	N22110
R255	314	1			½	N22111
R256	458	1			½	N22112
R257	1222	1			½	N22113
R258	1k	1			½	223642
R259	250	1			½	N22114
R260	800	1			½	N22115
R261	500	1			½	N22116
R262	900	1			½	N22117
R263	111·1	1			½	N22118
R264	990	1			½	N22119
R265	10·1	1			½	N22120
R266	1k	1	Erie	109	½	221025
R267	1222	1	Painton	73	½	N22113
R268	660	1			½	N22103
R269	962	1			½	N22104
R270	1466	1			½	N22105
R271	2475	1			½	N22106
R272	5500	1			½	N22107
R273	55	1	Painton	73 H.S.	½	N22108
R274	122	1			½	N22109
R275	206	1			½	N22110
R276	314	1			½	N22111
R277	458	1			½	N22112
R278	250	1			½	N22114
R279	800	1			½	N22115
R280	500	1			½	N22116
R281	1k	1			½	223642
R282	111·1	1			½	N22118
R283	900	1			½	N22117
R284	10·1	1			½	N22120
R285	990	1			½	N22119
R286	0·47	10		MV1 W.W.	1½	238101
R287	1k	1	Erie	109 H.S.	½	221025
R288	1k	2			½	221125
R289	1·5k	1	Painton	P405 W.W.	6	N22261
R290			NOT FITTED			
R291	100	10	Erie	9 Carbon	½	226313
R292	100	10			½	226313

RESISTORS (VARIABLE)

Circuit Ref.	Value Ohms	Tol. %	Manufacturer	Type	Rating Watts	Solartron Part No.
RV60	250/250	10	A.B. Metals	43 W.W.	1	N25803
RV61	1k/250	10			1	N25751
RV62	1k	10	Colvern	CLR1206/9S W.W.	½	256410
RV63	1k	10			½	256410
RV64	1k	10			½	256410
RV65	10k	10		CLR4201/11 W.W.	1	256663

CAPACITORS

Circuit Ref.	Value Pfd.	Tol. %	Manufacturer	Type	Rating Volts	Solartron Part No.
C60	1·59μF	½	T.M.C.	S125480 Po	50	N20149
C61	0·159μF	½	R.B.S.	S.M.	250	N20063
C62	0·0159μF	½			250	N20064
C63	1572pF.	½			250	N20065
C64	1·59μF	½	T.M.C.	S125480 Po	50	N20149
C65	0·159μF	½	R.B.S.	S.M.	250	N20063
C66	0·0159μF	½			250	N20064
C67	1572pF.	½			250	N20065
C68	2μF	25	Hunt	W49/B5404 M.P.	250	206505

MISCELLANEOUS

Circuit Ref.	Type	Description	Manufacturer	Solartron Part No.
FS1	L1055/5A	Fuse 5A	Belling and Lee	372276
M1	B103/G2	Meter	Sangamo Weston	B103/G2
LP1		Lamp Festoon 6V 3W	Vitality	
SK1	MS9	Micronector 9 pin	McMurdo	
SK2	MS9			
SK3	MS9			
SK4	MS9			
SK5	MS9			
SK6	MS9			
SK7	MS9			
SK8	MS9			
SK9	MS9			
SK10	CZ49221	Mk. IV 4-way. pos. 0	Plessey	
TL1		Terminal L1001/1SW	Belling and Lee	408461
TL2				408461
TL3				408461
TL4				408461
TL5				408461
TL6				408461
TL7				408461
TL8				408461
TL9				408461
SW1		Switch Wafer	Walter Instruments	261030
SW2				261030
SW3				261030
SW4				261031
SW5				261032
SW6				261033
SW7				
SW8		Switch Toggle	Bonnella	276226
SW9				
SW10				
SW11		Switch	Arrow Elect.	276254
PSU		Power Sub-unit	Solartron	AS754/300

SECTION 5
SETTING UP THE COMPLETE OSCILLATOR

All sub-units must have been set up as previously described before proceeding with the setting up of the complete oscillator.

Preliminary Adjustments

Switch on the instrument and allow 15 minutes to warm up. Use a variac to ensure that the supply voltage is correct.

Check the output from the power supply sub-unit, and adjust RV1 on the sub-unit if necessary for 300 V output. Adjust RV51 for 100 V between earth and the — 100 V line.

Amplitude Balance

Set the frequency controls to 100 × 1 and monitor the 90° output with an accurate A.C. voltmeter having high input impedance. Adjust RV61 and if necessary RV62 for 10 V rms output.

Alternately monitor 270° and 90° outputs and adjust RV11 (1st image amp) and RV2 (1st drive amp) for 10 V output.

Adjust RV22 on the 0° and 180° output amplifiers for 10 V output on the 0° and 180° phases.

D.C. Levels

Connect an avometer model 8 (2·5 V range) from the 90° terminal to earth and adjust RV1 (1st drive amp) for zero D.C.

Connect an avometer model 8 (2·5 V range) from the 270° terminal to earth and adjust RV12 (1st image amp) for zero D.C.

Alternately adjust RV1 and RV12 until the 90° and 270° outputs are coincident at earth potential. If this set-up cannot be achieved, the — 100 V rail may be varied 1 volt and the setting up repeated.

Connect an avometer model 8 (2·5 V range) from the 0° and 180° outputs to earth and adjust RV1 on 0° and 180° output sub-units for zero D.C.

Check that there is zero quiescent potential and 10 V rms signal at each output. If any discrepancy is apparent, recheck the mains input voltage and repeat the setting up.

Meter Setting-up

Monitor the 0° output with an accurate A.C. voltmeter and adjust the 'Adjust to 10 V' control for 10 volts output.

Adjust RV60 so that the built-in meter reads precisely 10 V.

Amplitude Compensation

Set frequency controls 50–0–0 ×0·1.

Adjust RV61 for a reading of 10 V on the internal meter.

Switch the multiplier to ×1 and adjust RV62 for a reading of 10 V on the internal meter.

Switch the multiplier to ×10 and adjust RV63 for a reading of 10 V on the internal meter.

Switch the multiplier to ×100 and adjust RV64 for a reading of 10 V on the internal meter.

Performance Checks

Frequency Accuracy:

The frequency may be checked by displaying Lissajous patterns on an oscilloscope.

All settings of the decade controls should be checked with the multiplier at ×100.

Then, with the decade controls at 100–0–0, check the ×10 and ×1 positions.

Finally, set the decade controls at 0–0–0·1 and the multiplier at 0·1. Monitor the squarewave output with an oscilloscope, and time 5 cycles of oscillation with a stop-watch.

Attenuator Accuracy:

Set the oscillator to a frequency of 1 Kc/s. Connect a high impedance accurate A.C. millivoltmeter from the 0° attenuator output to earth. Switch in the internal 1 KΩ.

Set the attenuator to 10 and adjust the output level to 10 V.

Check all the attenuator positions.

Repeat the test on the 180° phase.

Phase Error at 10 Kc/s:

This test requires a Solartron Resolved Component Indicator, type VP250.

Set the frequency of oscillation at 10 Kc/s.

Connect the VP250 reference input to the 0° output of the oscillator and the signal input to the 90° output. Note that the VP250 gives a lead indication and record the reference meter indication (call this reading A).

Reverse the signal and reference leads and note that the VP250 now gives a lag indication. Record the reference meter indication (call this reading B).

The phase error will be less than $\frac{A+B}{3}$ degrees, where A and B are expressed as percentages of 10 V.

These readings should be repeated between the 180° and 270° phases.

Amplitude Balance:

Using an accurate A.C. voltmeter to monitor the four phases of output in turn, set the 90° output to 10 V and check that the other three phases are within 1% of 10 V at 20 c/s and 1 Kc/s.

Repeat at 10 Kc/s, when the balance should be better than 2%.

Check continuity between the four-phase output socket and terminals.

Pin A—0° Pin B—90° Pin C—180° Pin D—270°

Stability:

Monitor all output phases with an oscilloscope to ensure freedom from parasitic oscillation, when 500 Pfd is connected from each phase to earth.

Distortion:

For this test, a high impedance 100 c/s filter is required. The oscillator is set to 100 c/s with the output level at 10 V.

Connect the 0° output to the input of the filter, and

connect the output of the filter to an accurate A.C. millivoltmeter.
Multiply the voltmeter reading by the insertion loss of the filter and express the result as a percentage of 10 V.
Repeat on the other three phases. The distortion should never exceed 1%, although it is visible at the peaks of the wave on the 90° and 270° phases.
Squarewave Output:
Turn the squarewave amplitude control to maximum (fully clockwise) and set the oscillator frequency to 10 Kc/s.
Monitor the squarewave output with an oscilloscope. Check that the squarewave is symmetrical about earth and has an amplitude of approximately 18 V P–P. Measure the rise time which should not exceed 2 μsec. Check that the squarewave amplitude control is functioning correctly.
Amplitude Variation with Frequency:
Set the oscillator to 5 Kc/s and set the output level to 10 V on the internal meter.
Check the meter reading at the following frequencies using the lowest multiplier setting for each frequency.
10 Kc/s, 5·55 Kc/s, 1 Kc/s, 500 c/s, 100 c/s, 10 c/s, 5 c/s, 1 c/s, 0·5 c/s, 0·1 c/s, 0·05 c/s, 0·01 c/s.
The meter indication should not vary more than 5%. The meter should not swing more than ± 5% even at lowest frequencies.

FAULT LOCATION CHART

Standard Test Procedure for Localisation of Faults:
1. Measure the H.T. voltage from the power supply sub-unit on pin C5 of SK14 (300 V) to H.T. negative.
2. Measure the negative voltage output at pin A3 on PL1 (negative 100 V to earth).
3. Open circuit both connections to pins 1 and 2 of the meter M1.
4. Connect pin B1 to pin B3 on SK2 of the 1st drive amplifier. This earths the input to the 1st drive amplifier. The same result may be achieved by earthing the wiper on the rear wafer of SW1.
5. Measure the D.C. voltage at the following test points in order:—
(*a*) 1st Drive amplifier pin B5 SK2.
(*b*) 1st image amplifier pin B5 SK7.
(*c*) 2nd drive amplifier pin B5 SK3.
(*d*) Squarer circuit pin B5 SK9.
(*e*) Maintaining amplifier pin B5 SK4.
(*f*) 2nd image amplifier pin B5 SK8.
The rear connections of the sub-unit sockets are near the bottom of the printed circuit board. Looking from the front of the instrument, the upper line of four contacts is the A row, and the lower line of five contacts is the B row. The numbers read from left to right.
This constitutes the main amplifier loop and a faulty sub-unit will be indicated by excessive or uncontrollable D.C. voltage at the output of the fault unit. The normal should be zero volts relative to earth and slight errors may be corrected by use of the appropriate control on each sub-unit. A faulty sub-unit may be replaced with a spare unit of the appropriate type, if available, and adjusted to match the main unit. Alternatively, remove the unit and check valves and other components to clear the fault.
6. Then measure the D.C. voltage at the following points, which are outside the main oscillatory loop:—
(*a*) 0° output amplifier pin B5 on SK5.
(*b*) 180° output amplifier pin B5 on SK6.
(*c*) Squarer circuit pin B4 on SK9.
Note: *Both of the drive units and both of the output amplifiers are identical and therefore interchangeable.*

SYMPTOMS	POSSIBLE CAUSE	REMEDY
Complete failure.	Open circuit fuse. T1 in the power supply sub-unit. Wiring open circuit between A.C. input plug and T1 primary winding.	Change the fuse. Check the continuity and insulation of T1 primary winding. Check the mains input circuitry to the primary winding of T1.
No H.T. at pin C5 of SK14.	Fault in the power supply H.T. unit.	Change the valves in the H.T. unit. Check the output voltage from T1 to the rectifier valve. Check the components in the regulator section of the unit.
Incorrect negative 100 V at pin A4 of the negative rail sub-unit. Top left pin.	Faulty sub-unit. R289 between pin A3 of SK1 (earth) and pin A4 of SK9 (H.T. negative).	Measure the continuity of R289. Change the valves in the sub-unit. Check other components of the sub-unit, particularly divider networks.
Not oscillating under any operating conditions.	Fault in the main oscillatory loop.	Carry out the standard test procedure to localise the fault. Remove faulty sub-unit and replace if a spare unit is available. Change the valves and check the other circuit components in the faulty unit. Replace faulty components.

SYMPTOMS	POSSIBLE CAUSE	REMEDY
Not oscillating on any single decade setting.	Open circuit resistor in either of the phase-shift networks.	Locate and replace the relevant faulty resistor on the selected switch position.
Not oscillating on any selected frequency multiplier switch position.	Open circuit capacitor or wiring on either section of the phase-shift networks.	Locate and replace the faulty capacitor. Repair the broken wiring.
Meter reading low or meter not reading with the output at the terminals normal.	One or both thermocouples in the meter open circuit. Open circuit meter wiring.	Replace the meter and readjust RV60. Check the continuity of wiring in the meter circuit.
Meter needle hard over to the right.	Excessive output due to a fault in the maintaining amplifier. Excessive D.C. voltage from the 1st or 2nd drive amplifiers.	Measure the D.C. voltages applied to the meter. Check the maintaining amplifier input circuit R212, 214, 216, RV61.
Squaring of output from the 0° or 180° phase only.	Open circuit cathode resistor in the 0° or 180° amplifier. Open circuit feedback control in the faulty amplifier.	Measure the continuity of R17 in the faulty amplifier. Measure the continuity of RV2 in the faulty amplifier.
High amplitude clipped output on all phases.	Fault in the main oscillatory loop.	Adopt the standard test procedure. Measure the continuity of the feedback circuit in the faulty amplifier. Measure the value of the output cathode resistor in the faulty sub-unit.
Output balance between phases greater than the error relative to the 0° phase.	Low gain in any sub-unit.	Adjust the individual gain controls of the sub-units as specified in paragraph 3.1 of the setting-up procedure.
No squarewave output.	Fault in the squarer sub-unit. V31, V32, V33.	Monitor the input on pin B1 (bottom right) of SK9. Monitor the output at pin B5 and pin B4 (1st and 2nd left bottom row) on SK9 in order. Check the continuity of the squarewave amplitude control RV65. If no squarewave at pin B5 change V31, V32, and check circuitry. If squarewave is at pin B5 but not at B4 change V32, V33 and check circuitry. If squarewave is at pin B4 check output wiring and amplitude control.
Attenuator not operating on the 10–4·5 V range.	The internal 1K ohm must be in circuit unless proper termination is supplied externally. The internal 1K ohm resistor on either phase open circuit. SW8 faulty. SW10 faulty.	Switch in the terminating resistor. Measure the continuity of the terminating resistors. Check switch 8 and switch 10.
Divider of 5 V or 2 V sections of attenuator not working correctly.	Faulty SW6 or SW7, or associated resistor.	Check the continuity through the switch contacts. Check the continuity of the relevant resistors for the faulty range.
Attenuated output faulty at any individual setting of the attenuator switching on either phase.	The relevant resistor on the selected switch position open circuit or changed value. Faulty switch contact.	Locate and change the faulty resistor. Repair or replace the faulty switch contact.
Excessive phase error between phases at high frequencies.	Open circuit frequency compensating capacitors in any sub-unit.	This fault would normally result in a frequency shift and therefore be self-correcting if the error is originated in any sub-unit contained in the main oscillatory loop. The predominant symptom would be a frequency error despite the fact that the phase-shift components in the frequency decade are correct. If the phase-shift error were introduced in the 0° or 180° amplifiers, which are outside the main oscillatory loop, the predominant symptom would probably be an amplitude error at high frequencies and the phase-shift error would be measured across the individual sub-unit.

Note: *All connections and pin numbers mentioned in the above are located on the centre printed board, with the exception of PL*14, *which is accessible on the right-hand side of the unit.*

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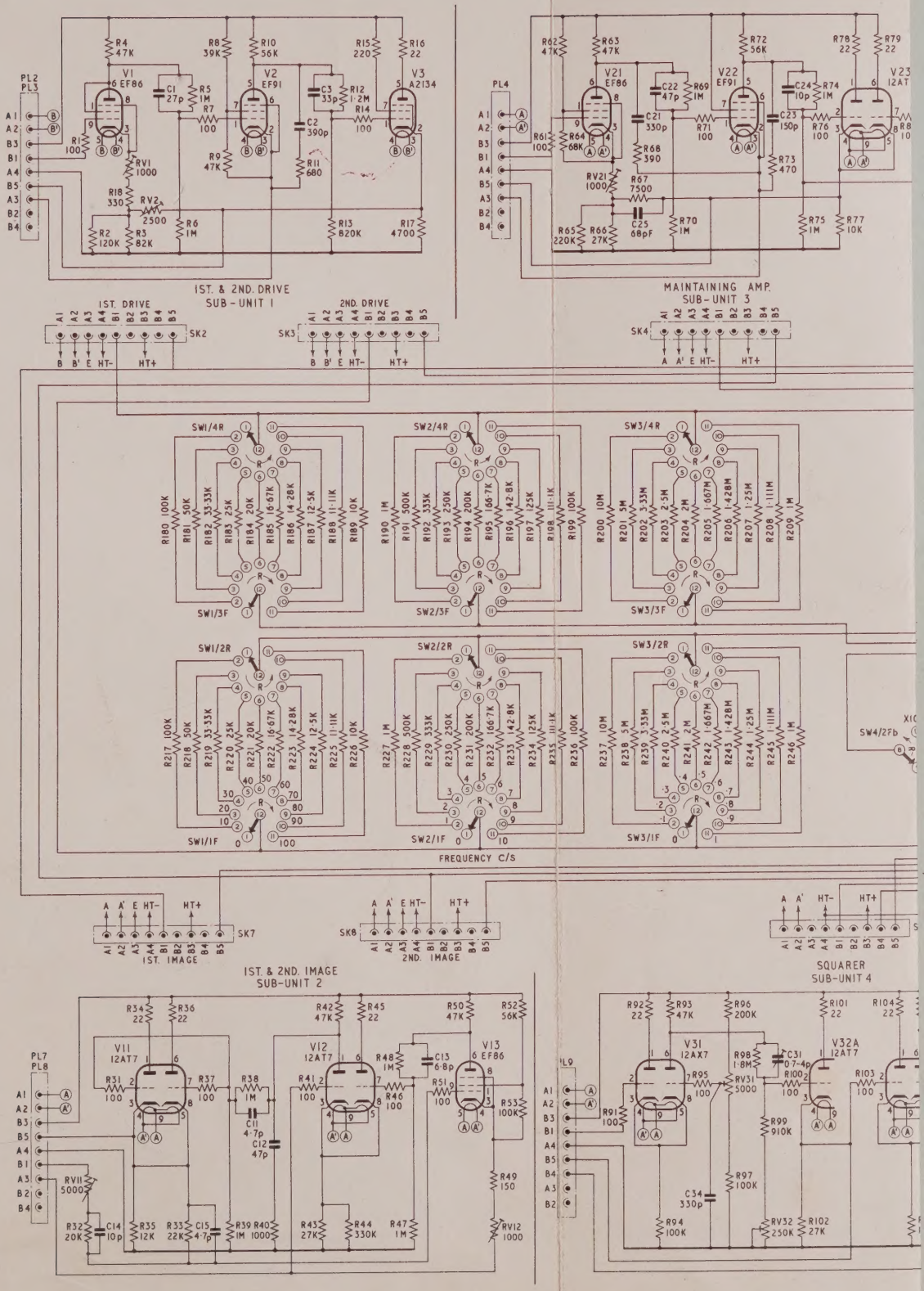

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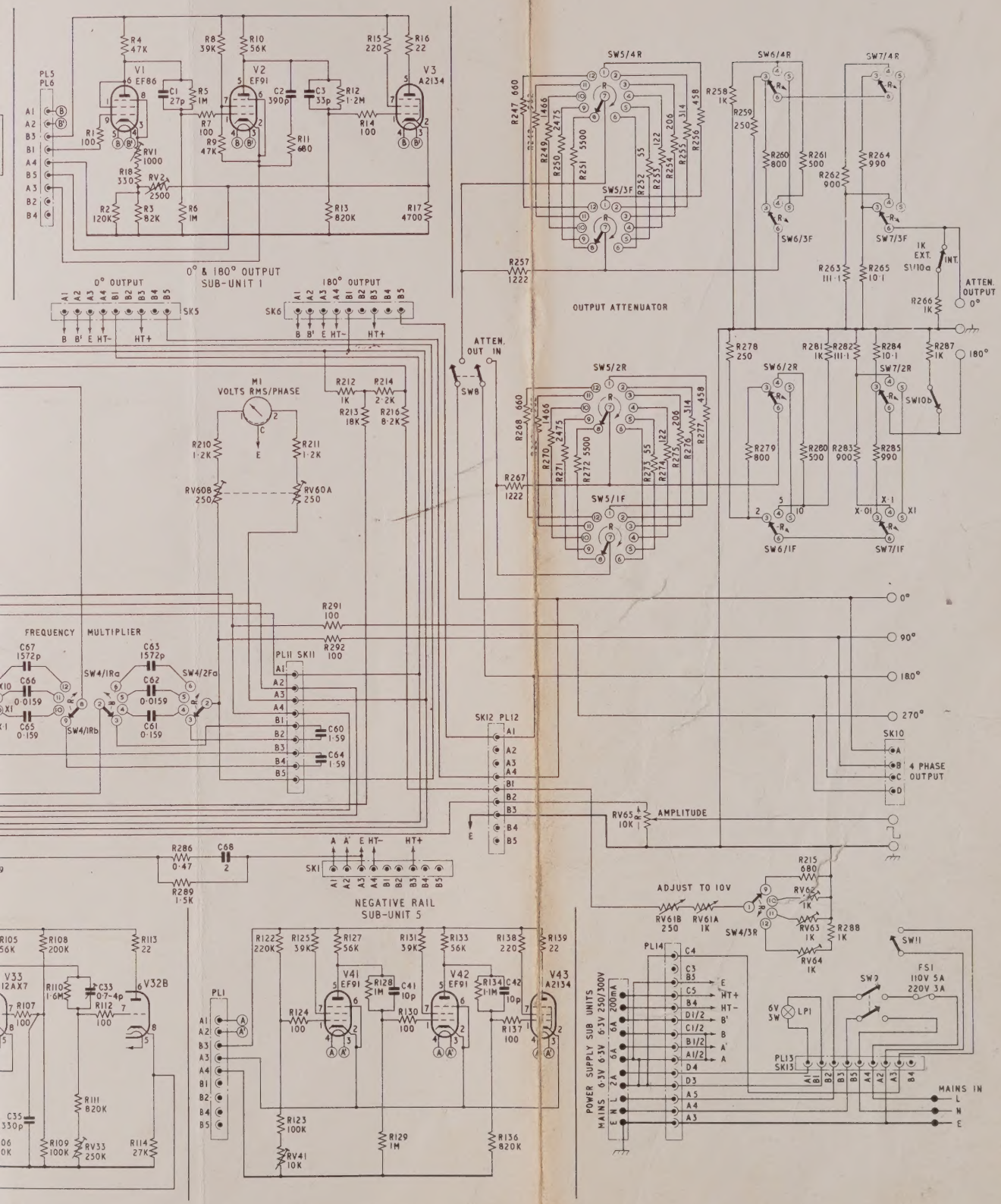

de Oscillator OS103. 2 Circuit Diagram

MP MASTER
MA24434